

## Description

# *VARIABLE INPUT SPEED TO WATER PUMP*

### BACKGROUND OF INVENTION

[0001] The invention relates generally to water pumps and more specifically to water pumps having a variable speed input.

[0002] Water pumps are typically used on vehicles today to provide heat transfer means for an engine during operation. Water pumps are typically driven by the engine crankshaft at a fixed ratio. Thus, as the engine idle speed is reduced, as is the trend in vehicles today to reduce emissions, the water pump speed is correspondingly reduced. This reduction in water pump speed results in a reduction in the coolant flow through the cooling system which can result in poor heater output for the interior of the vehicle when needed in cold weather and also can result in poor coolant flow for engine cooling during hot weather.

[0003] Increasing the water pump speed by increasing the drive ratio from the crankshaft will increase the coolant flow at

engine idle speeds, but it may result in overspeeding the pump at higher engine speeds which may produce pump cavitation and reduced water pump bearing life. Pump cavitation can result in pump damage and a reduction in cooling system performance.

[0004] The current state of the art is to add an auxiliary water pump, typically electrically driven, to provide additional coolant flow at low engine idle speeds. Another approach is to use moveable vanes in the inlet of the water pump to throttle the coolant flow at higher engine speeds.

[0005] It is thus an object of the present invention to provide good coolant flow at low engine idle speeds while avoiding pump cavitation at higher engine speeds without the need for an auxiliary water pump or moveable vanes.

#### **SUMMARY OF INVENTION**

[0006] The above and other objects of the invention are met by the present invention that is an improvement over known water pumps.

[0007] The present invention provides a method and apparatus for providing good coolant flow at low engine idle speeds while avoiding pump cavitation at high engine speeds. This is accomplished by increasing or overdriving the input speed to an existing water pump at low engine speeds

and decreasing the input speed at higher engine speeds.

[0008] In one preferred embodiment of the present invention, a variable ratio drive belt system is used to drive the water pump. By increasing and decreasing the size of the variable pitch driver and driven members as a function of engine speed, the water pump speed can be increased at low engine speed to provide improved coolant flow and decreased at higher engine speeds to prevent pump cavitation.

[0009] Other features, benefits and advantages of the present invention will become apparent from the following description of the invention, when viewed in accordance with the attached drawings and appended claims.

#### **BRIEF DESCRIPTION OF DRAWINGS**

[0010] Figure 1 is a perspective view of a cooling system having a water pump driven by a variable drive ratio belt system according to one preferred embodiment of the present invention;

[0011] Figure 2 is an exploded view of the crankshaft pulley of Figure 1;

[0012] Figure 3 is an exploded view of the water pump pulley of Figure 1;

[0013] Figure 4 is a side view of the water pump and crankshaft

- pulleys of Figure 1 in a midrange engine speed situation;
- [0014] Figure 5 is a side view of the water pump and crankshaft pulleys of Figure 1 in a low engine speed situation; and
- [0015] Figure 6 is a side view of water pump and crankshaft pulleys of Figure 1 in a high engine speed situation.

#### **DETAILED DESCRIPTION**

- [0016] Referring now to Figure 1, cooling system 10 having a water pump 12 driven by a variable drive ratio belt system 14 is depicted. The belt system 14 has a drive belt 16 coupled to a variable pitch crankshaft pulley 18, or driver pulley, and a variable pitch water pump pulley 20, or driven pulley.
- [0017] To drive the water pump 12, engine speed is rotationally translated to an engine crankshaft 22 from the engine (not shown) in a manner well known in the art. The rotational speed is then transferred from the crankshaft 22 to the variable pitch crankshaft pulley 18. The rotation of the crankshaft pulley 20 causes rotation of the coupled drive belt 16, which in turn causes rotation of the variable pitch water pump pulley 20. The rotation of the variable pitch water pump pulley 20 causes the water pump bearing shaft 24 to rotate, which in turn causes the water pump impellers 28 to rotate, thereby providing engine coolant

flow to the engine block in a method well known in the art. The water pump bearing shaft 24 is supported and sealed within the water pump housing 30 by a water pump bearing 26.

[0018] The variable pitch crankshaft pulley 18 has two pulley halves 18a, 18b that each have an inner sloping surface 19a and 19b onto which the drive belt 16 rests. As the halves are pulled apart, the drive belt 16 rests more centrally on the inner sloping surfaces 19a, 19b, corresponding to a smaller belt diameter, which changes the drive ratio to the water pump pulley. The pulley halves 18a, 18b are pulled together or pushed away in a coordinated fashion to an open or closed position. A spring (shown in Figure 2 as 60) maintains the halves 18a, 18b at a first distance D1 apart in the absence of engine crankshaft rotation.

[0019] Similarly, the variable pitch water pump pulley 20 has two pulley halves 20a, 20b each having an inner sloping surface 21a, 21b that may be pulled together or pushed apart in a coordinated fashion to an open or closed position. As the halves 20a, 20b are pulled apart, the drive belt 16 rests more centrally on the inner sloping surfaces 20a, 20b, corresponding to a smaller belt diameter, which

increases the drive ratio to the water pump pulley and allows the variable pitch water pump pulley 20 to rotate more quickly. This in turn allows the coupled water pump bearing shaft 24 and impellers 28 to rotate more quickly, which increase the water pumped to the engine block by the water pump 12. A spring (shown as 82 in Figure 3) maintains the water pump halves apart at a distance D2 in the absence of drive belt 16 rotation. The mechanism for opening and closing the crankshaft pulley halves 18a, 18b and water pump pulley halves 20a, 20b is described below in Figures 4–6.

[0020] Thus, by controlling the positioning of the crankshaft pulley halves 18a, 18b relative to the water pump pulley halves 20a, 20b, the rotational speed of the water pump impellers 28 coupled to the water pump pulley 18 can be varied at a given engine speed.

[0021] Referring now to Figure 2, an exploded view of the variable pitch crankshaft pulley 18 according to one preferred embodiment is shown. This variable pitch crankshaft pulley 18 of Figure 2 is a 340 Series Driver Unit manufactured and sold by Go Kart Supply, Inc. of Keithville, Louisiana. The pulley 18 is shown as having a thrust spacer 50, a fixed face and stem 52, an idler bushing 54, a splined

washer 56, a plurality of spline liners 58, a moveable face 74, a plurality of shims 76, a ramp plate 78, a spacer 80, a retainer 82, and a lock washer 84. The variable pitch crankshaft pulley 18 also has a spring 60, a pair of bushings 62, a roller kit 64, a pivot pin 66, a bushing 68, a bushing 70, and a spring 72. Note that this existing model 340 unit shown is designed to move the pulley halves in the opposite direction with increasing speed than is needed for this invention. A modification to the pivot and spring mechanism would be needed to provide the desired movement of the pulley halves.

[0022] Figure 3 shows an exploded view of a variable pitch water pump pulley 20 according to a preferred embodiment of the present invention. As above, the preferred variable pitch water pump pulley 20 depicted in Figure 3 is a 340 Series Driven Unit manufactured and sold by Go Kart Supply, Inc. of Keithville, Louisiana. The variable pitch water pump pulley 20 is shown as having a fixed face and post 86, a bushing 88, a spacer 89, a moveable face 90, a spring 82, a cam 96 with buttons 74, and a set screw 98.

[0023] Figures 4, 5 and 6 are side views of the variable pitch crankshaft pulley 18 and variable pitch water pump pulley 20 at low engine speeds, medium engine speeds, and

high engine speeds.

[0024] Preferably, for low engine speeds, as depicted in Figure 4, the water pump pulley halves 18a, 18b are forced apart by the spring 82 and the moveable face 90. At the same time, the crankshaft pulley halves 20a, 20b are forced together by spring 60 and movable face 74, thereby maintaining tension on the drive belt 16. This provides a small belt contact diameter of the variable pitch water pump pulley 20 for drive belt 16 on the inner sloping surfaces 21a, 21b and large belt contact diameter for the drive belt 16 on the inner sloping surfaces 19a, 19b of the crankshaft pulley 18. This small belt contact diameter of the variable pitch water pump pulley 20 translates more rotation to the water pump bearing shaft 24 per unit length of the drive belt 16, thereby providing relatively high impeller 28 speed to provide high water (coolant) flow to the engine block.

[0025] As engine speed increases to a midrange engine speed, as shown in Figure 5, the crankshaft pulley halves 18a, 18b are forced apart by increased centrifugal force created by the rotation of the crankshaft 22 (and translated to the variable pitch crankshaft pulley 18) against the spring 60 and movable face 74, therein increasing the distance D1



between pulley halves 18a, 18b. The increased rotational speed of the drive belt 16 also increases the relative centrifugal force on the water pump pulley 20. This increased centrifugal rotational force forces together the water pump pulley halves 20a, 20b against the force of the spring 82 and moveable face 90, therein decreasing the distance D2 between the pulley halves 20a, 20b.

[0026] This results in a larger belt contact diameter for the variable pitch water pump pulley 20 and a smaller belt contact diameter to the variable pitch crankshaft pulley 18 than in Figure 4. As one of ordinary skill appreciates, the larger belt diameter on the water pump pulley 20 at the given drive belt 16 rotational speed means more length of drive belt 16 is required to rotate the pulley 20 one full rotation, therein inducing less rotation of the water pump bearing shaft 24 and impellers 28 per unit drive belt 16 in response. Thus, the amount of coolant flow is decreased in the present invention at this midrange engine speed as compared with a traditional water pump unit having a standard belt diameter at a midrange engine speed.

[0027] As speed is increased further to a high engine speeds, as shown in Figure 6, the crankshaft pulley halves 18a, 18b are forced fully apart and the water pump pulley halves

20a, 20b are forced fully together by this centrifugal force action. This provides a smallest possible belt contact diameter for the crankshaft pump pulley 18 and largest possible belt contact diameter to the variable pitch water pump pulley 20.

[0028] As one of ordinary skill realizes, the use of the variable drive belt system 14 provides a unique solution for uncoupling impeller speed from engine speed. The present invention thus aids in minimizing or preventing pump cavitation that may occur at high impeller speeds with water pumps in the prior art not utilizing the variable drive belt system 14. The absence of pump cavitation is generally considered to increase the life expectancy of the water pump and cooling system. Further, by varying the strength of springs 60 and 82, one can vary the rate of movement of the pulley halves in response to centrifugal effect induced by rotation of the drive belt 16. Thus, the variable drive belt system 14 can be made more sensitive or less sensitive to engine speed fluctuations depending upon the desired coolant flow output at the range of available engine speeds.

[0029] While the best modes for carrying out the present invention have been described in detail herein, those familiar

with the art to which this invention relates will recognize various alternate designs and embodiments for practicing the invention as defined by the following claims. All of these embodiments and variations that come within the scope and meaning of the present claims are included within the scope of the present invention.